FINAL REPORT

DETAILS

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PROJECT MANAGER	E Hugo
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Corresponding author: HugoE@arc.agric.za

Introduction

Although grain sorghum (*Sorghum bicolor* (L.) Moench.) production has shown a decline during the past decade, it is still regarded as one of the most drought tolerant grain crops under cultivation. Africa is the largest sorghum producing continent with approximately 21.6 million tons (MT) produced annually (http://www.grains.org.sorghum, assessed 19 July 2010). Although sorghum has a high yield potential, low yields in Africa and India are still experienced.

Effective weed control is one of the largest challenges if high yields and quality grain are to be achieved and maintained. Weed control in sorghum is challenging since sorghum is a relatively slow growing crop and is sensitive to most herbicides that can be effectively used in maize production. Crop-weed competition must be kept to a minimum during early emergence and seedling development of sorghum (Ferrel, *et al*., 2008). To control graminious weeds in a crop of the same taxonomic order has always been difficult. Grass infestations early in the season is most detrimental to sorghum production (Smith, *et al*., 1990).

Early control of weeds is important to prevent yield losses (Muzik, 1970; Klingman, *et al*., 1982, Zimdahl, 1999) which varies between 10 - 20 % per season. Although a number of pre-emergence graminicides are registered in South Africa for control of grass weeds in sorghum, effective control is still not optimal. Crop injury is occasionally experienced whereas full spectrum weed control is often not achieved and carry-over to follow-up crops may also occur (Limon-ortega, *et al*., 1998; Claborn *et al*., 1999). Herbicide selectivity for sorghum enhanced considerably with the introduction of safeners or protectants during the late 1970's and early 1980's (Foy & Witt, 1990). Currently, fluxofenim [1-(4-chlorophenyl)-2,2,2,-trifluoro-1-ethanone-O-(1,3-dioxolan-2-ylmethyl)oxime] (Concept®) is used as a seed dressing on all sorghum cultivars planted in South Africa to protect seed when alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-methoxymethyl)acetamide] and S-metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] are to be applied pre-emergence for grass control in sorghum production. Without the use of seed protectants severe crop injury will be experienced ranging from poor emergence, whiplashing of leaves and stunting (Simkins, *et al*., 1980; Roeth *et al*., 1983). Pre-emergence herbicides registered on sorghum in South Africa are mainly from the chloroacetamide group, including mixtures with triazines and include active ingredients such as acetochlor [2-chloro-*N*-(ethoxymethyl)-*N*-(2-ethyl-6-methylphenyl)acetamide], alachlor, propazine [2-chloro-4,6-bis(isopropylamino)-*s*-triazine], S-metolachlor, dimethenamid [2-chloro-*N*-[(1-methyl-2-methoxy)ethyl]-*N*-(2,4-dimethyl-thien-3-yl)acetamide] and terbuthylazine [6-chloro-N-(1,1-dimethyl)-N'-ethyl-1,3,5-triazine-2,4-diamine] (http://www.croplife.co.za, assessed 19 July 2010). In general, the use of pre-emergence herbicides is tolerated well by sorghum plants provided that the prescribed seed protectant is used. Studies did, however, show that crop injury can still be experienced despite protectants being used (Foy & Witt, 1990).

The possible effect of pre-emergence herbicides on seedling growth and yield of various sorghum cultivars, both under optimal and sub-optimal environmental conditions, is not well documented and crop damage vary greatly between seasons. Some herbicide labels still warn producers against possible crop injury resulting from the use of pre-emergence herbicides especially under cold, wet environmental conditions. The objective of this study was therefore to determine the sensitivity of various sorghum cultivars to chloroacetamide containing herbicides and to establish if early season crop damage has any effect on sorghum yield.

Material and methods

This study comprised of one glasshouse trial and four field trials conducted during 2007/08 and 2008/09. Field trials were further split into an early and late planting date at each locality.

Glasshouse trial

Three most-commonly used herbicides from the chloroacetamide family were tested on three sorghum cultivars, PAN8247, PAN8420 and PAN8609, using two soil types with different clay contents. The experimental design was a complete randomised block design with four replicates per treatment. Soil was collected from experimental farms of the ARC at Potchefstroom and Bethlehem with clay contents of 35% and 16%, respectively. Soil analyses are presented in Table 1. A summary of the herbicides tested and dosage rates used is presented in Table 2. Alachlor (480 $g.l^{-1}$), S-metolachlor (916 $g.l^{-1}$) and S-metolachlor/terbuthylazine (102.8/497.2 $g.l^{-1}$) were applied at both registered dosage rates and double this rate according to label specification for each soil type. A control treatment, where no herbicides were applied, was included for each treatment on both soil types. One pot was used per treatment-replicate. Polyethylene pots (20cm in diameter) lined with plastic bags were each evenly filled with 4 kg soil. Sorghum seed was treated with Concept® 960 EC according to label specifications for herbicides from the chloroacetamide family. Soil water content to field capacity was determined with the pot weighing method for both soils. Herbicides were applied pre-emergence (Pre-E) one day after planting by means of a specially designed conveyer belt pot sprayer with an even flat fan spray nozzle (8002E) (spray width 50cm). The sprayer delivered a spray mixture at the equivalent of 250 $l\ ha^{-1}$. After herbicide application 100 ml water was applied to each pot in order to leach and activate the herbicides into the soil. The trial was watered regularly to ensure no water stress. Holes at the bottom of each pot allowed free drainage. Chemicult fertilizer was applied to each pot (±100ml) after emergence of all seedlings to prevent nutrient deficiencies. Pots were kept in the greenhouse at optimal conditions (15°C / 28°C, night/day) for the duration of the trial (40 days). Natural day length was app. 13 hours.

The mean time to emergence, total number of emerged seedlings and visual symptoms of phytotoxicity were recorded throughout the observation period. Plant height (cm) was measured weekly up to 40 days after planting (DAP). Dry mass (g) was recorded 40 DAP when the above-ground plant parts (stems and leaves) were cut off and dried at 55°C for

48h. Visual phytotoxic symptoms such as whiplashing of leaves, curling of leaves, chlorosis, necrosis, stunting and malformation of plant parts were recorded by comparing plants from treated pots with the untreated control. Visual phytotoxicity was expressed as a percentage of the untreated control treatments (EPPO, 2007).

Field trials

Two field trials were conducted at the above mentioned experimental farms during 2007/08 and 2008/09. The experimental layout was a split-plot design with herbicide treatments as subplots and cultivars as whole-plots, replicated three times. The same herbicide treatments were used as for the glasshouse experiment except for S-metolachlor/terbuthylazine that was not applied during 2007/08. Five sorghum cultivars, PAN8247, PAN8389, PAN8420, PAN8609 and PAN8648, were planted at both localities and evaluated to determine sensitivity to herbicides from the chloroacetamide family. Two planting dates were used at both localities to simulate early and late season planting. Early planting was done in the first week of November and the late planting in the last week of November for both seasons. Plot size was four rows per cultivar x 5m, with an inter-row spacing of 0.5m. Seedbed preparation was done according to the standard cultivation methods for each soil type. Herbicides were applied pre-emergence using tractor sprayers delivering 186 l ha^{-1} at 300KPa at Potchefstroom and 320 l. ha^{-1} at 550KPa at Bethlehem. Trial sites received overhead irrigation of 20 mm, 2 DAP to ensure herbicide activity in the soil. Control plots for each cultivar were included and were kept free from weeds by hand hoeing to compare plant height, dry mass, herbicide damage and yield differences. Plant height (cm) and dry mass (g) of above-ground plant parts were recorded 35, 45 and 60 DAP at both Potchefstroom and Bethlehem, using five sorghum plants per plot (15 per replicate). Plants were cut off just above the soil surface and were dried at 55°C for 48h to determine dry shoot mass. Visual phytotoxicity was recorded 23 and 40 DAP at both localities. Grain yield was determined by hand harvesting ears of the middle two rows of each plot at physiological maturity (14% moisture). The mass of a thousand seeds was determined for each plot at both localities during both seasons.

Data were expressed as a percentage of the control for both glasshouse and field trials and were subjected to multi-factorial analyses using Genstat 9th edition for Windows. Data of each soil type were analysed separately. Data for each variable were analysed as a split-plot design for the field trials. Means were compared at P=0.05 using Fisher's protected LSD test. All possible main effects and interactions were tested. Each season's data of the field trials were analysed separately and each year-location combination was considered to be an environment.

Results

<u>Glasshouse</u>

Cultivar and herbicide treatments had no significant effect on mean time to germination for all sorghum cultivars grown in clay soil (35% clay), which germinated on average 7 DAP, and which is commercially acceptable (ISTA, 2009). However, significant main effects and an interaction between herbicide treatments and cultivars were recorded for cultivars planted on sandy soil (16 % clay) (data not shown). Compared to the emergence of other treatments, PAN8420 took significantly longer (9 days to emergence) to germinate where alachlor was applied at 2 x dosage rate. All other cultivars geminated within 7 DAP.

Within the two soil types, only herbicide treatments had a significant reduction in total seedling emergence when compared to control treatments (Table 3). Stand loss was expressed as % of the control of total seedling emergence. The highest reduction in stand loss was recorded for the S-metolachlor 2 x treatments applied on clay soil (35 %). However, stand loss on sandy soil was > 20 % compared to 14.2 % on clay soil. No significant interaction was recorded between cultivars and herbicide treatments for both soil types.

Visual phytotoxicity (%) was overall higher on emerged sorghum seedlings in clay soil than in sandy soil, (24 % compared to 3 % respectively). The cultivar x treatment interaction was significant for both soil types. Of the main effects, herbicide treatments had the greatest effect on phytotoxicity on both soil types while cultivars had a significant effect on phytotoxicity only on the clay soil. Visual percentage of phytotoxicity was higher in all the treatments receiving double the dosage rates (Table 4). On clay soil, PAN8420 was highly sensitive to both S-metolachlor and alachlor at double the dosage rates. All sorghum cultivars showed, however, phytotoxicity of >20% in both S-metolachlor/terbuthylazine treatments on clay soil (Table 4). Sorghum cultivars outgrew, however, the visual symptoms 40 DAP on both soil types.

On both soil types cultivar, herbicide treatments and the interaction thereof had a significant effect on plant height. Plant height was, however, not significantly different in treatments where registered dosage rates (1x) were applied, except for alachlor on sandy soil (Table 5). Sorghum culitvars planted in sandy soil was >10% stunted with both alachlor dosage rates. PAN8609 showed the largest effect with stunting of > 25 %. Sorghum cultivars was significantly more stunted in 2x the dosage rates of both S-metolachlor and alachlor treatments on clay soil. As similar tendencies were observed with regard to dry mass of sorghum plants in both soil types, detailed data are not discussed.

Field trials

Total rainfall measured from October to March for the 2007/08 season did not differ much between localities with 524 mm recorded at Potchefstroom and 582 mm at Bethlehem. Total rainfall for the 2008/09 season, however, was far less at Potchefstroom (417 mm) than at Bethlehem (550 mm). Seedling emergence was not significantly affected by herbicide treatments at both localities during both seasons and stands were commercially acceptable (> 95 %).

The decrease in plant height on sandy soil (16 % clay) was significant for the first planting during 2007/08 and for the second planting during 2008/09 (Fig. 1). Herbicide treatments and cultivars both had a significant effect on mean plant height (% of control) on 35 % clay soil during both seasons (Fig. 2). Cultivars had a significant effect on plant height during both seasons on sandy soil. A decrease in plant height was more severe during the 2007/08 season where alachlor was applied at both rates, especially during the first planting on clay soil and the second planting on sandy soil (Fig. 1a and Fig. 2b). Sorghum plants did, however, outgrew these stunting effects between 45 and 60 DAP at both localities.

Cultivars reacted differently within each herbicide treatment over seasons at both localities (Tables 6). Stunting of sorghum was more evident early in the season during 2007/08 on clay soil. PAN8389 seemed to be more stunted on clay soil 30 DAP during both seasons when compared to the rest of the cultivars. Cultivars in the second planting showed, however, no stunting throughout the 2008/09 season on clay soil (Table 6). Cultivars were more stunted on sandy soil during the second planting in 2007/08 early in the season, but outgrew these stunting 60 DAP (Table 6). Cultivars showed the least stunting on sandy soil in the first planting during 2008/09 (Table 6). No significant interaction for plant height was recorded between cultivars and herbicide treatments at both localities during both seasons.

Cultivars had the greatest effect on grain yield (1 000 seed mass) on both soil types for both seasons (F-values). Herbicide treatments had only a significant effect in the late planting during 2007/08 on sandy soil (Table 7) and during the 2008/09 season on clay soil (both early and late plantings) (Table 8). PAN8420 showed a significant decrease in yield of > 10 % where S-metolachlor was applied at the registered dosage rate in the second planting during 2008/09 on clay soil (Table 8). The same tendency regarding yield was observed in S-metolachlor treatments on sandy soil for both dosage rates, although not significant. Yield was also significantly reduced (> 7 %) during the second planting in S-metolachlor (2X) and alachlor (1X and 2X) treatments. PAN8247 had the highest yield when planted early in the season during both seasons on clay soil (Table 7 and 8). The late planting of cultivars on sandy soil resulted in lower yields for all cultivars during both seasons, except for PAN8247 during 2008/09 (Table 8). Brown *et al*., (2004) found that sorghum plants can sustain some level of injury without manifesting too large reductions in yield. Sorghum yield loss due to chloroacetamide herbicides was also found to be 10% or less where sorghum plants did not fully recover form crop injury early in the season (Geier, *et al*., 2009).

Conclusions

Seedling emergence in the glasshouse trial was significantly influenced by herbicide treatments on both soil types and was not significantly affected by cultivars. S-metolachlor 2x showed severe phytotoxicity in the form of reduced seedling emergence (stand loss) on both soil types. Visual phytotoxicity of emerged seedlings, observed as whiplashing of leaves and stunting of plants, was higher on clay soil, but most plants outgrew these symptoms within 40 DAP. Stunting was more severe in both alachlor and s-metolachlor treatments where double the dosage rate was applied on both soil types.

Good seedling emergence and crop stands in field trials were recorded for all sorghum cultivars on both soil types. Treatments where alachlor was applied showed more stunting on both soil types. However, stunting of cultivars was inconsequent between cultivars and seasons on both soil types. The reduction in yield was more cultivar related and herbicide treatments did not reduce yields consistently over seasons on both soil types. Planting date of sorghum had a significant effect on sorghum yield. Early planting of sorghum favoured most cultivars on sandy soil and had the least reduction on yield. These field trials were a good example of sorghum production in South Africa. Yield losses do occur from season to season, but depends mostly on cultivar choice and environmental conditions. Herbicide applications do cause crop damage either as visual symptoms or in reduction of crop stands and varies between 7 - 10 %. However, no single herbicide treatment had a consistent significant negative effect on sorghum yield during both season on both soil types. All herbicides tested have the potential to damage sorghum severely when a favourable condition (wet and cold weather, sensitive culitvar) prevails and if applied incorrectly.

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Tables:

Table 1 Analyses of experimental soil

Soil	P	K	Ca	Mg	Na	Sand	Clay	Silt	pH(KCl)
	mg kg^{-1}					%			
Bethlehem (FS)	78.6	135	504	135	40	79	16	5	4.34
Potchefstroom (NW)	65	220	988	308	20	55	35	10	4.79

Table 2 Herbicides and dosage rates applied on the different soil types

Herbicide treatments (Active ingredient)		35% clay	16% clay
		Dosage rate l/ha	
S-metolachlor		915 g/l	
	1x	0.95	0.8
	2x	1.9	1.6
alachlor		480 g/l	
	1x	4.0	3.6
	2x	8.0	7.2
S-metolachlor/terbuthylazine		102.8/497.2 g/l	
	1x	3.7	3.0
	2x	7.4	3.0

Table 3 Effect of six herbicide treatments on stand loss of sorghum on both soil types in the glasshouse

Herbicide treatments	Stand loss (% of Control)		
	DR	16% clay	35% clay
Control	-	0.0a	0.0a
S-metolachlor	1x	20.0b	7.46ab
	2x	28.9b	30.3c
alachlor	1x	21.6b	16.2b
	2x	21.6b	18.1b
S-metolachlor/terbuthylazine	1x	20.0b	13.7b
	2x	18.3b	13.4b

Table 4 Effect of three cultivars and six herbicide treatments on visual phytotoxicity in the glasshouse on two soil types

	Phtytotoxicity (% of control)							
16% clay	DR	PAN8247	PAN8420	PAN8609	Mean	ANOVA		
Control	-	0.00	0.00	0.00	0.00a	Source	F	P
S-metolachlor	0.80	0.00	0.00	0.00	0.00a	A: Cultivar	0.68	0.51
	1.60	11.25	8.33	0.00	6.53ab	B:	2.82	0.02
alachlor	3.60	0.00	0.00	0.00	0.00a	Treatments		
	7.20	0.00	0.00	12.50	4.17ab	Interaction:	2.65	0.01
S-metolachlor/terbuthylazine	3.00	6.25	0.00	0.00	2.08a	A x B		
	6.00	5.00	18.75	0.00	7.92b			
Mean		3.21a	3.87a	1.79a				
LSD(A x B)	9.64							
35% clay								
Control	-	0.00	0.00	0.00	0.00a	ANOVA		
S-metolachlor	0.95	13.30	31.20	13.30	19.30.ab	Source	F	P
	1.90	25.00	87.50	37.10	49.90.c	A: Cultivar		
alachlor	4.00	10.00	5.00	20.80	11.90ab	B:	4.63	0.01
	8.00	16.70	65.80	12.50	31.70bc	Treatments	4.84	<0.001
S-metolachlor/terbuthylazine	3.70	33.30	25.00	25.00	27.80b	Interaction:		
	7.40	25.00	31.00	56.00	31.00bc	A x B	2.21	0.02
Mean		14.8a	35.2b	23.6ab				
LSD(A x B)	35.57							

Table 5 Effect of three sorghum cultivars and six herbicide treatments on mean plant height in the glasshouse

Soil type	Mean plant height % control							
16% clay	DR	PAN8247	PAN8420	PAN8609	Mean	ANOVA		
Control	-	100.0	100.0	100.0	100.0a	Source	F	P
S-metolachlor	0.8	106.9	107.6	101.5	105.3a	A: Cultivar	6.47	0.003
	1.6	89.3	102.8	95.7	95.9a	B: Treatment	4.80	<0.001
alachlor	3.6	93.5	87.7	75.6	85.6b	Interaction:		
	7.2	96.2	92.9	82.9	90.7b	A x B	2.00	0.039
S-metolachlor/terbuthylazine	3.0	96.1	106.6	94.2	98.9a			
	6.0	82.3	113.3	94.3	96.9a			
Mean		94.9a	101.6b	92.0a				
$LSD_{(A \times B)}$	14.36							
35% clay								
Control	-	100	100	100	100.00a	ANOVA		
S-metolachlor	0.95	89.35	101	100.81	97.06a	Source	F	P
	1.9	96.59	80.03	92.81	89.81c	A: Cultivar	3.00	0.057
alachlor	4.0	97.44	106.17	102.41	102.01a	B: Treatment	5.17	<0.001
	8.0	92.06	82.17	104.94	93.05bc	Interaction:		
S-metolachlor/terbuthylazine	3.7	93.69	96.69	99.31	96.56ab	A x B	3.58	<0.001
	7.4	94.22	92.16	87.42	91.26bc			
Mean		94.76	94.03	98.24				
$LSD_{(A \times B)}$	9.71							

Table 6 Effect of five sorghum cultivars planted on two soil types during 2007/08 and 2008/09 on mean plant height in two field trials (early and late planting dates)

	Plant height (% of Control)			
	35% clay		16% clay	
2007/08	Early planting			
DAP	30	60	30	60
PAN8247	91.50a	98.50bc	89.76a	96.16a
PAN8389	85.80a	95.20c	93.99a	92.07a
PAN8420	90.10a	98.40bc	91.71a	99.64a
PAN8609	88.70a	102.10b	95.65a	95.13a
PAN8648	92.10a	108.00a	98.61a	97.73a
	Late planting			
PAN8247	97.52ab	99.02ab	81.32b	99.30bc
PAN8389	95.87b	95.00c	89.50a	101.60b
PAN8420	102.29a	96.81bc	82.10b	95.88c
PAN8609	95.20b	98.73abc	84.61ab	105.63a
PAN8648	99.26ab	102.48a	83.77b	100.16b
2008/09	Early planting			
PAN8247	97.96b	97.13a	114.70a	110.50c
PAN8389	84.43c	98.38a	102.90bc	121.30a
PAN8420	95.99b	95.36a	96.50c	109.90c
PAN8609	101.48a	97.53a	110.60ab	115.20b
PAN8648	98.15ab	97.98a	105.70abc	107.60c
	Late planting			
PAN8247	106.40ab	106.50c	95.77a	96.33bc
PAN8389	107.20a	103.30c	94.40a	94.85c
PAN8420	103.80abc	130.70a	101.96a	103.52a
PAN8609	101.60bc	105.50c	95.14a	94.33c
PAN8648	100.00c	124.00b	100.96a	100.07ab

Table 7	Effect of early and late planting date on the mass of a 1000 seeds for four herbicide treatments and five sorghum cultivars planted on two soil types during 2007/08

16% clay		Mass of 1000 seed (% of control)					
Early	DR	PAN8247	PAN8389	PAN8420	PAN8609	PAN8648	Mean
Control	-	100.00	100.00	100.00	100.00	100.00	100.00a
S-metolachlor	0.8	103.85	100.06	102.24	94.52	99.18	98.56a
	1.6	98.17	109.29	107	102.41	98.92	93.39a
alachlor	3.6	102.17	104.82	101.47	98.47	112.6	93.77a
	7.2	97.1	106.13	104.51	96.74	92.81	93.13a
Mean		93.38a	101.55a	96.5a	96.35a	91.06a	
$LSD_{(AxB)}$		ns					
Late							
Control	-	100	100	100	100	100	100.00a
S-metolachlor	0.8	90.08	112.83	99.22	96.05	94.6	98.56a
	1.6	93.56	100.01	98.06	95.5	79.81	93.39b
alachlor	3.6	89.72	101	93.29	92.89	91.93	93.77b
	7.2	93.54	93.9	91.96	97.31	88.96	93.13b
Mean		93.38bc	101.55a	96.50b	96.35b	91.06c	
$LSD_{(AxB)}$		7.623					
35% clay							
Early							
Control	-	100	100	100	100	100	100.00a
S-metolachlor	0.95	101.61	95.39	87.18	99.17	101.32	96.93a
	1.9	98.29	99.47	85.2	98.51	94.56	95.21a
alachlor	4.0	106.96	94.99	84.71	100.29	101.18	97.63a
	8.0	103.82	101.25	83.33	93.28	97.75	95.89a
Mean		102.14a	98.22a	88.08b	98.25a	98.96a	
$LSD_{(AxB)}$		ns					
Late							
Control	-	100	100	100	100	100	100.00a
S-metolachlor	0.95	92.62	88.74	86.6	96.95	89.52	90.88a
	1.9	97.34	87.52	91.99	99.58	94	94.08a
alachlor	4.0	102.6	93.08	100.38	95.53	91.53	96.62a
	8.0	94.92	92.67	92.97	97.42	91.09	93.81a
Mean		97.49a	92.40b	94.39ab	97.90a	93.23b	
$LSD_{(AxB)}$		ns					

Table 8 Effect of early and late planting date on the mass of a 1000 seeds for four herbicide treatments and five sorghum cultivars planted on two soil types during 2008/09

16% clay		Mass of 1 000 seed (% of control)					
Early	DR	PAN8247	PAN8389	PAN8420	PAN8609	PAN8648	Mean
Control	-	100	100	100	100	100	100
S-metolachlor	0.8	98.16	101.25	102.51	103.46	103.68	101.81a
	1.6	103.73	103.19	98.49	102.24	107.22	102.98a
alachlor	3.6	103.75	104.71	101.45	104.23	101.19	103.07a
	7.2	100.12	97.5	102.71	99.9	99.37	99.92a
S-metolachlor/terbuthylazine	3	95.47	99.18	99.76	94.46	94.86	96.75a
	6	99.58	101.01	93.91	96.33	99.94	98.15a
Mean		100.12a	100.98a	99.83a	100.09a	100.90a	
$LSD_{(AxB)}$		ns					
Late							
Control	-	100	100	100	100	100	100.00a
S-metolachlor	0.8	96.2	85.98	96.88	95.46	89.17	92.74a
	1.6	93.49	86.22	92.12	88.69	96.14	91.33a
alachlor	3.6	102.68	94.65	92.97	90.53	96.45	95.45a
	7.2	101.22	94.08	91.09	90.12	88.5	93.00a
S-metolachlor/terbuthylazine	3.0	103.93	99.76	89.16	94.8	89.77	95.48a
	6.0	101.4	99.88	95.95	97.37	93.75	97.67a
Mean		99.85a	94.37b	94.03b	93.85b	93.40b	
$LSD_{(AxB)}$		ns					

35 % clay		Mass of 1 000 seed (% of control)					
Early							
Control	-	100	100	100	100	100	100.0bc
S-metolachlor	0.95	119.31	100.61	99.77	98.48	101.36	103.91ab
	1.9	111.08	105.72	104.42	104.24	96.6	104.41a
alachlor	4.0	104.98	103.68	98.84	97.37	96.98	100.37abc
	8.0	110.67	95.54	103.52	95.53	86.59	98.37cd
S-metolachlor/terbuthylazine	3.7	105.5	86.59	99.33	90.74	93.78	95.19d
	7.4	113.78	99.77	104.33	101.09	94.46	102.69ab
Mean		109.33a	98.85bc	101.46b	98.21bc	95.68c	
$LSD_{(AxB)}$		9.043					
Late							
Control	-	100	100	100	100	100	100.0a
S-metolachlor	0.95	94.38	85.63	109.73	102.47	99.18	98.28a
	1.9	90.97	79.52	94.34	95.9	90.63	90.27b
alachlor	4	94.94	94.91	96.32	110.4	98.8	99.07a
	8	93.89	83.56	98.4	105.55	101.66	96.61a
S-metolachlor/terbuthylazine	3.7	101.29	85.93	98.79	105.86	93.77	97.13a
	7.4	103.86	88.13	90.46	106.97	105.69	99.02a
Mean		97.05b	88.24c	98.29b	103.88a	98.53b	
$LSD_{(AxB)}$		ns					

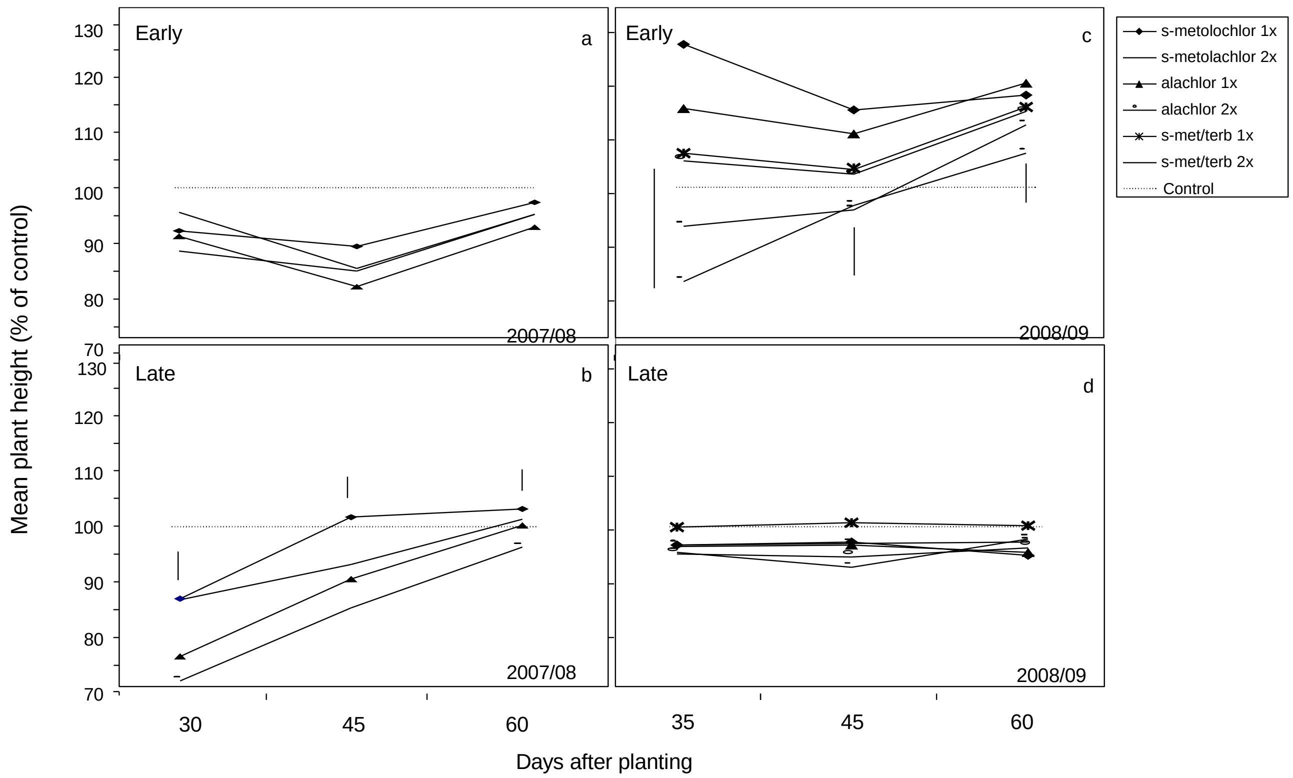

Fig. 1 Effect of six herbicide treatments on mean plant height on sorghum planted in sandy soil (16%) at Bethlehem. (Points without LSD bar denotes non-significance)

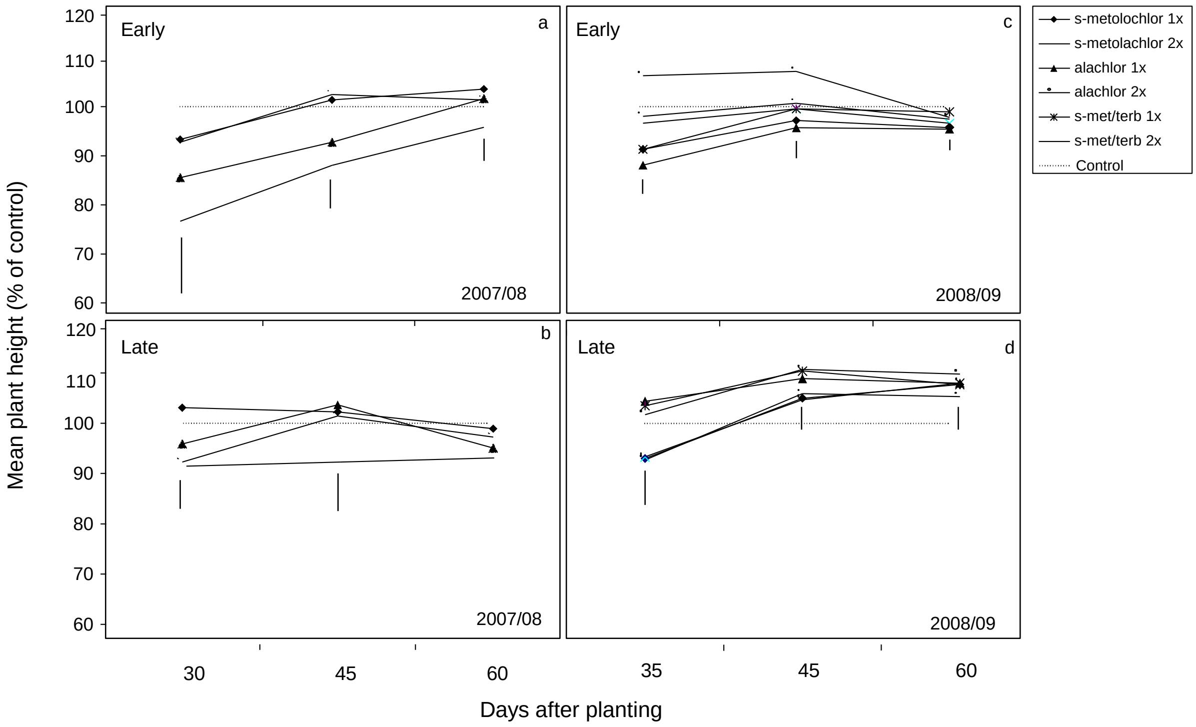

Fig. 2 Effect of six herbicide treatments on mean plant height on sorghum planted in clay soil (35 %) at Potchefstroom. (Points without LSD bar denotes non-significance)

Appendix A

ANOVA Table of the mass of a 1 000 seed

Bethlehem 2007/08					Bethlehem 2008/09			
	Plant 1		Plant 2		Plant 1		Plant 2	
	MASS OF 1000 SEED				MASS OF 1000 SEED			
Source	F	P	F	P	F	P	F	P
Treatment	1.23	0.373	6.71	0.011	2.59	0.076	2.19	0.117
Cultivars	1.63	0.185	11.09	<0.001	0.29	0.882	3.98	0.006
Interaction								
A X B	1.15	0.346	3.14	0.002	0.89	0.616	1.13	0.347
Potchefstroom 2007/08					Potchefstroom 2008/09			
	Plant 1		Plant 2		Plant 1		Plant 2	
	MASS OF 1000 SEED				MASS OF 1000 SEED			
Source	F	P	F	P	F	P	F	P
Treatment	2.69	0.109	3.65	0.056	5.76	0.005	3.84	0.023
Cultivars	13.56	<0.001	3.14	0.025	18.31	<0.001	12.75	<0.001
Interaction								
A X B	1.56	0.126	0.9	0.578	1.79	0.038	1.44	0.131